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LARVAL FISH SAMPLING IN LAKE HURON, 1978

D.H. Loftus

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LARVAL FISH SAMPLING IN LAKE HURON, 1978

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Ministry of
Natural
Resources

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ABSTRACT

Loftus, D. H. 1982. Larval fish sampling in Lake Huron, 1978.

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The Lake Huron Fisheries Assessment Unit obtains annual indices of abundance of larval lake herring, lake whitefish and yellow perch. The indices are derived from data on weekly catches at sites in Severn Sound and in the Bruce area during the period from late April until early July. Larval lake herring and whitefish abundance is expressed as a simple tabulation of weekly catch values. Separate indices of abundance are obtained for yellow perch swim-up fry ("recruits") and pelagic larvae ("survivors"). Observed densities of "survivors" are corrected for avoidance using the data of Noble (1968). Successive weekly estimates of both "recruits" and "survivors" are added so that indices reflect total hatch size and survival. This method assumes that between-site differences in abundance are systematic and that emigration is balanced by immigration. Yellow perch "survivors" seemed more abundant in 1978 in Severn Sound than in either 1976 or 1977. Larval lake herring in the Bruce area were also relatively abundant but larval whitefish abundance was intermediate between that of 1976 and 1977.

Keywords: Lake Huron, larval fish, yellow perch, whitefish, lake herring.

LARVAL FISH SAMPLING IN LAKE HURON, 1978

INTRODUCTION

The objective of the larval fish sampling program in Lake Huron is to obtain annual indices of abundance of larval lake herring *(Coregonus artedii)*, lake whitefish *(Coregonus clupeaformis)* and yellow perch *(Perca flavescens)*. These indices will be used, alone and in combination with other variables, as first approximations of year class strength.

A time-series of such indices is required to establish their reliability as indicators of subsequent year class strength, which is estimated through index fishing and commercial catch sampling programs.

This report presents the results of the work of 1978, the first year in which a virtually complete series of catch data was obtained. Data collected in 1976 and 1977 were incomplete so that only the most conservative between-year comparisons can be made. These earlier reports emphasized aspects of program development (Loftus 1977, 1978). This report includes a description of the sampling gear, sampling design and a discussion of indices of abundance.

METHODS

SAMPLING GEAR:

The net used (Fig. 1) is a modified version of that described by Faber (1967a). The 9.5 mm (3/8 in.) steel ring has an inside diameter of 0.8 m, so that the area of the opening is 0.5 m^2. The fine seine material (mesh size, ≈ 450 μ) that was originally used in the net body had a filtration efficiency of 90% to 93% at tow velocities of 0.35 m/sec to 0.70 m/sec. Maximum efficiency occurred at velocities of 0.5 m/sec to 0.6 m/sec. This material has been replaced with 500 μ plain woven square polyester mesh which is more widely available and is also thought to have a higher filtration efficiency.

The cod end has a capacity of 2.0 L and is constructed of 10.2 cm (4 in.) PVC pipe capped with a plexiglass disk. Straining windows cut in the wall of the cod end are covered on the inside with brass milk straining screen. A twist-lock mechanism is used to secure the cod end to the sampler.

SAMPLING DESIGN:

Sampling is conducted primarily in the Bruce area and in Severn Sound, although limited sampling is also done at South Baymouth. The

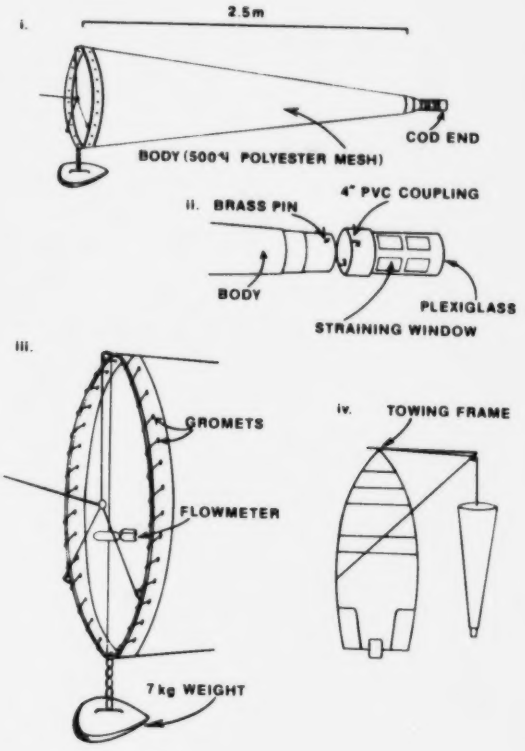

Figure 1. Design of the sampling gear.

sampling period extends from late April until late May at South Baymouth, and from late April until the end of June in the two main sampling areas.

Sampling sites (Fig. 2 and 3) were chosen with regard to the ease of obtaining the desired species and to the need for representation from widely separated locations. Catch data are expected to yield information on the differences in larval abundance between sites and between years. In contrast to the approach taken by such other investigators as Forney (1976), McWilliams (1976) and Noble (1968), no attempt is made to estimate population size.

Samples were collected at weekly intervals in Severn Sound and the Bruce area and at intervals of 2 to 4 days at South Baymouth. Details of the distribution of the sampling effort are given in Table 1.

The size of the sampling areas, and the distance between them, makes this a more practical approach, logistically, than sampling intensively over a short time period. Also, the sampling areas are complex rather than homogeneous with the result that local microclimatic differences lead to differences in hatching times. Consequently there is no specific time

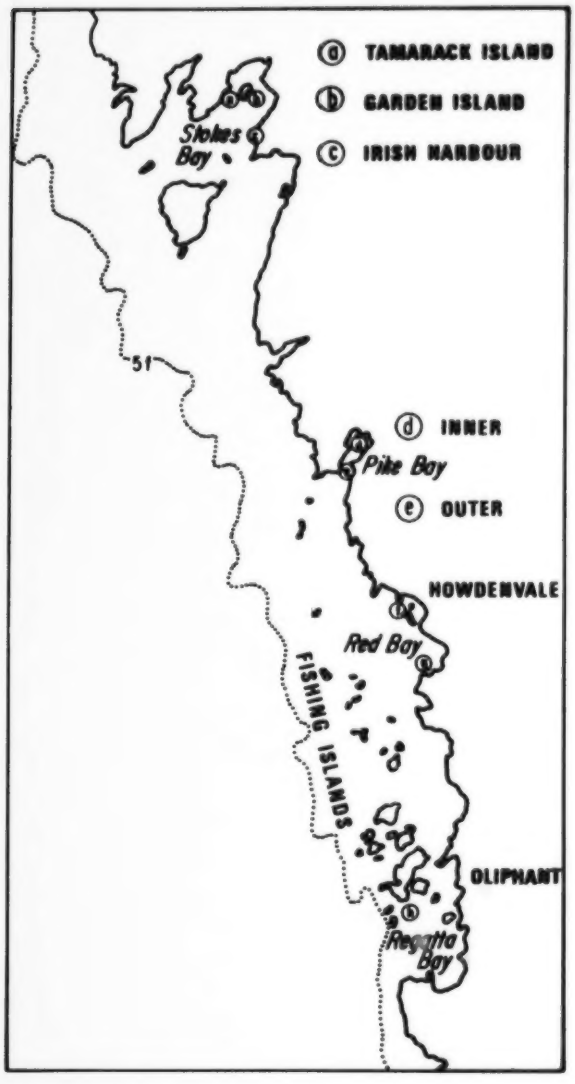

Figure 2. Larval trawling sites in the Bruce area, Lake Huron.

at which all larvae are in the same stage of development. Finally, the extended sampling period is necessary to obtain data on species which do not appear contemporaneously and to document the abundance of yellow perch in both early and late stages of development.

Indices of abundance are calculated for individual sites. These can be combined into area-wide indices. Thus the sampling design allows comparisons of relative annual abundance of individual sites, between sites and between areas. Systematic differences in abundance are expected to occur between sites and the strength of the design will be partly determined by the degree of covariation in annual index values.

SAMPLING TECHNIQUE:

Only surface tows were made and all tows were 5 minutes in duration. The *Delta H*, a 21-foot vessel powered by two 70 hp outboard engines, was used to collect samples in Severn Sound. A 16-foot aluminum outboard powered skiff was used in the Bruce area. These vessels are adequate except under rough lake conditions.

Average effective tow velocity, as measured with a General Oceanics flowmeter, was 0.73 m/sec in 1978 compared with 0.70 m/sec in 1977. Individual catch sizes were expressed as the number of larvae per 1000 m^3 of water. All catch-per-unit-effort (CUE) values in this report are given in these terms unless otherwise specified.

INDEX CALCULATION:

Separate indices of abundance are obtained for yellow perch swim-up fry ("recruits") and pelagic larvae ("survivors"). Recruits have been arbitrarily defined as those perch larvae ranging between 5 mm and 8 mm in total length. Larvae between 12 mm and 15 mm in length are considered to be survivors. The 3 mm width of these length classes was chosen to correspond closely with the weekly length increment of individual larvae[1] so that complete replacement would occur within each size group each week.

Individual catch sizes for recruits and survivors were obtained by using length-frequency data to determine what proportion of the total perch catch was comprised by each group. Each of the three 1.0 mm wide length classes in the survivor group was multiplied by a correction factor to compensate for avoidance (see Table 2). No such adjustment was considered necessary for larvae in the recruits group (Noble, 1968).

Median adjusted CUE values were used rather than arithmetic or geometric means to establish central tendency in catch size at each site each week. Successive weekly values were then summed to obtain an index of recruits (r) and an index of survivors (s) for each site.

Site-specific values of r and s can be combined into area-wide indices of abundance. The method used by Loftus (1978, p.20) to obtain area-wide indices for Severn Sound in 1976 and 1977 was applied to the 1978 data as well for the purpose of comparison. Earlier data were incomplete, however, and the degree of

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[1]Growth rate estimates for yellow perch larvae in Severn Sound were 3.7 mm/wk in 1977 and 4.3 mm/wk in 1978. These estimates agree closely with those of Noble (1968) for Oneida Lake perch (3.2 mm/wk to 4.6 mm/wk). The estimated growth rate of Pike Bay perch larvae was 5.0 mm/wk.

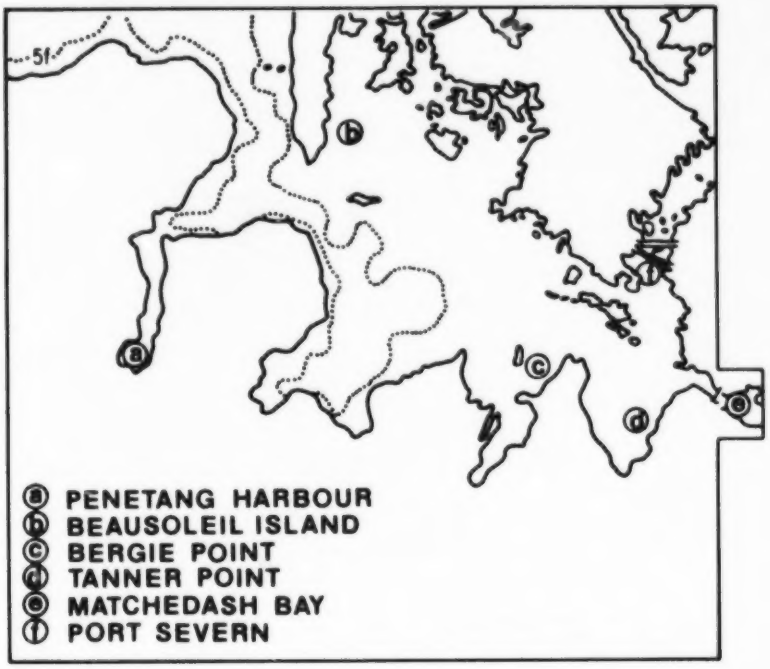

Figure 3. Larval trawling sites in Severn Sound.

Table 1. Distribution of sampling effort.

Area	Sub-Area	Location	Tows/ Sampling Date	Total No. Tows
Bruce	Fishing Islands	Red Bay	3	30
		Howdenvale Bay	3	30
		Regatta Bay	3	30
	Pike Bay	Inner Bay	3	30
		Outer Bay	3	30
	Stokes Bay	Tamarack	3	30
		Irish Harbour	3	30
		Garden Island	3	30
Severn Sound	Hog Bay	Bergie Point	4	40
	Matchedash Bay	Matchedash Bay	4	40
	Sturgeon Bay	Tanner Point	4	40
	Severn	Port Severn	4	40
	Penetang Bay	Penetang Harbour	4	40
	Beausoleil	Beausoleil Island	4	40

Table 3. Efficiency of fry sampler in relation to Miller high speed samplers with and without an electrified grid (after Noble, 1968).

Length Class (mm)	Relative Efficiency: Miller-grid / Miller-no grid	Relative Efficiency: Miller fry	Relative Efficiency: Miller-grid[d] fry	Capture Rate of fry sampler (%)
5-6	1.00[a]	1.00[c]	1.00	100
6-7	1.00	1.00	1.00	100
7-8	1.00	1.00	1.00	100
8-9	1.00	1.00	1.00	100
9-10	1.00	1.00	1.00	100
10-11	1.00	1.05	1.05	95
11-12	1.11[b]	1.35	1.50	67
12-13	1.30	1.65	2.15	47
13-14	1.52	1.95	2.96	34
14-15	1.79	2.25	4.03	25
15-16	2.10	2.55	5.36	19
16-17	2.46	2.85	7.01	14
17-18	2.89	3.15	9.10	11
18-19	3.39	3.45	11.70	9
19-20	3.97	3.75	14.89	7
20-21	4.05	4.05	18.89	5

[a]Samplers were equally efficient in capturing larvae 5 mm to 11 mm in length (Noble 1968, Fig. 13). Noble assumed avoidance rate by fish larvae of Miller sampler preceded by electrified grid was 0%.

[b]Relative efficiency values for larvae in the 11 mm to 21 mm range calculated from equation given by Noble (1968, Fig. 13): $\ln RE = 1.74 + 0.16\ TL$, ($R^2 = .70$).

[c]According to Noble (1968, Fig. 6) the fry sampler was more efficient at capturing larvae 10 mm. For our purposes, however, values remain at unity.

[d]Calculated from data in preceding two columns.

replication was low, so that the precision of the 1976 and 1977 indices may be low as well.

Larval lake herring and whitefish abundance at the Bruce area sites is expressed simply as a tabulation of median weekly CUE values. No correction is made for avoidance.

ENVIRONMENTAL CONDITIONS

ICE COVER:

Stokes Bay was free of ice by mid-April although loose pack ice remained in the near-shore waters between Southampton and Pike Bay until around April 23[2]. Ice cover persisted in Severn Sound until the end of March.

WATER TEMPERATURE:

Continuous water temperature data are obtained from a Taylor Fulscope recorder installed at Beausoleil Island in Severn Sound. Water temperature at that location remained below 1.0°C until March 15. Effective warming began on April 20, about 10 days later than in 1977 (Fig. 4). The initial rate of warming was greater than it had been in 1977 with the result that by mid-May water temperature had reached 12°C in both years. This suggests that the initial warming rate may be a function of the time at which warming commences.

[2]Ice cover data for the Great Lakes are provided by Ice Forecasting Central, Environment Canada.

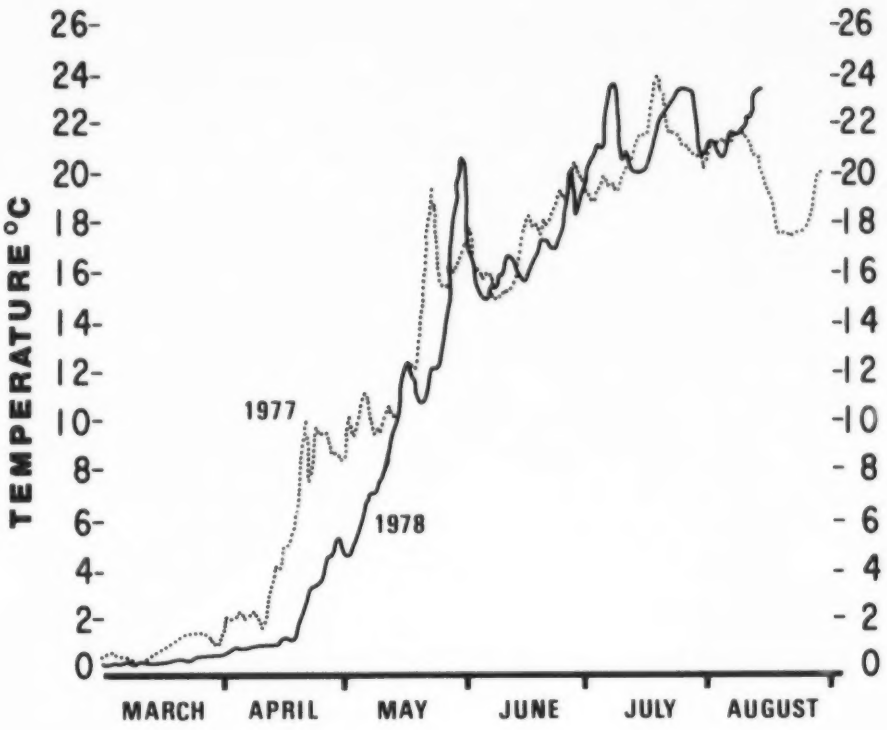

Figure 4. Variation in daily water temperature at Beausoleil Island, March to August, 1977 and 1978.

Water temperature in the Bruce area as measured with a hand thermometer during sampling operations was similar to that in Severn Sound, although temperature values observed in the Fishing Islands were almost invariably several degrees cooler.

WATER LEVELS:

Lake Huron water levels in 1978 were similar to those in 1977 but lower than in 1976. They continued to remain above the 1900 - 1977 average monthly levels.

RESULTS

YELLOW PERCH:

Severn Sound

Median weekly catch values and index values for the Severn Sound sampling sites are given in Table 3. Yellow perch larvae were first taken in catches during the week of May 14-20, one to two weeks later than in 1977. The relatively early hatch of 1977 is attributable to earlier warmings.

Individual swim-up fry densities were as high as $20/m^3$ at Bergie Point and $83/m^3$ at Tanner Point. Noble (1968, p. 70) remarked that equally high densities of perch larvae in Oneida Lake might lead to local food depletion, making dispersal from the nursery area essential for year class success. The occurrence of very heavy catches consisting almost entirely of recruits for two consecutive weeks at Tanner Point suggests that there may have been very little survival beyond the recruit stage at this location.

Surviving larvae were most abundant at Bergie Point and least abundant at Port Severn. As in 1977, an extremely large catch ($67/m^3$) of advanced larvae was made at Bergie Point. This is further evidence that larvae may aggregate at this location, voluntarily or otherwise, because of the protection it affords in rough weather.

Rough lake conditions prevented complete sampling during the week of June 11-17 and it was necessary to use means other than sampling to estimate larval perch densities at all sites except Penetang Harbour.

In general, survival in 1978 appears to have been much higher than in either 1976 or 1977. Area-wide indices of the abundance of recruits

Table 3. Median weekly CUE values for yellow perch in Severn Sound, 1978.

	Bergie Point	Matchedash Bay	Tanner Point	Penetang Harbour	Beausoleil Island	Port Severn
TOTAL CATCH						
May 7-13	0	0	0	0	0	0
May 14-20	5	2,606	23,788	0	378	24
May 21-27	8,121	1,326	26,445	1,008	2,360	643
May 28-June 3	10,117	862	1,642	195	2,473	503
June 4-10	4,234	1,484	1,374	219	200	62
June 11-17	2,700	300	485	140	81	0
June 18-24	221	0	23	18	0	0
June 25-July 1	18	0	0	0	0	0
July 2-8	7	0	0	0	0	0
RECRUITS						
May 7-13	0	0	0	0	0	0
May 14-20	5	2,606	23,788	0	378	24
May 21-27	7,279	1,176	26,121	1,008	750	627
May 28-June 3	4,452	110	252	70	132	44
June 4-10	53	0	0	0	10	0
June 11-17	0	0	0	0	0	0
June 18-24	0	0	0	0	0	0
June 25-July 1	0	0	0	0	0	0
July 2-8	0	0	0	0	0	0
TOTAL (r)	11,789	3,892	50,161	1,078	1,270	695
SURVIVORS						
May 7-13	0	0	0	0	0	0
May 14-20	0	0	0	0	0	0
May 21-27	0	0	0	0	0	0
May 28-June 3	0	0	0	0	600	0
June 4-10	4,715	1,481	1,545	130	300	68
June 11-17	3,300	600	860	235	60	0
June 18-24	357	0	26	14	0	0
June 25-July 1	34	0	0	0	0	0
July 2-8	0	0	0	0	0	0
TOTAL (s)	8,406	2,081	2,431	379	960	68

and survivors for the three years are given in Table 4. These values indicate that the 1978 year class is the strongest of the three for which indices are available. The need for conservative interpretation of this Table has already been stated.

Table 4. Indices of larval yellow perch abundance in Severn Sound, 1976-1978.

	Recruits	Survivors
1976	2,047	341
1977	981	686
1978	1,338	1,018

Bruce

Yellow perch catch data for the Bruce area are listed in Table 5.

Hatching apparently began on approximately May 10 in Pike Bay and Stokes Bay and a week later in the Fishing Islands where water temperature remained cooler.

Catches in Pike Bay and Stokes Bay were largest between May 21 and June 3. Larval perch

Table 5. Median weekly CUE values for yellow perch in the Bruce area, 1978.

	Stokes Bay	Pike Bay	Red Bay	Regatta Bay	Howdenvale Bay
TOTAL CATCH					
May 7-13	0	0	0	0	0
May 14-20	191	357	0	0	0
May 21-27	4,075	16,980	150	0	72
May 28-June 3	1,120	11,581	10	5	153
June 4-10	566	2,900	987	4	249
June 11-17	126	510	6	0	70
June 18-24	0	25	40	0	5
June 25-July 1	0	7	0	0	0
RECRUITS					
May 7-13	0	0	0	0	0
May 14-20	191	357	0	0	0
May 21-27	1,219	2,478	150	0	72
May 28-June 3	0	112	10	0	13
June 4-10	22	0	0	0	0
June 11-17	0	19	0	0	0
June 18-24	0	0	0	0	0
June 24-July 1	0	0	0	0	0
TOTAL (r)	1,432	2,966	160	0	85
SURVIVORS					
May 7-13	0	0	0	0	0
May 14-20	0	0	0	0	0
May 21-27	0	0	0	0	0
May 28-June 3	710	2,755	0	0	182
June 4-10	292	2,954	1,552	9	376
June 11-17	43	658	0	0	47
June 18-24	0	0	26	0	0
June 25-July 1	0	0	0	0	0
TOTAL (s)	1,045	6,367	1,578	9	605

densities reached $20/m^3$ in individual catches in Pike Bay at this time. Catches were negligible in Regatta Bay, an area unsuited for yellow perch spawning, and recruitment was also very low in Red Bay and Howdenvale Bay.

The abundance of survivors exceeded that of recruits in value in all areas except Stokes Bay. This suggests that immigration of larvae offsets losses due to mortality at most sampling locations. Immigration may be a usual occurence if the distribution of good larval perch habitat, such as that found in Pike Bay, is of limited extent. If this is the case, such areas are important centres of perch production.

Pike Bay and Stokes Bay are two of the more productive yellow perch nursery areas in the Bruce sampling area. Catch data for these areas was incomplete in 1977 (Loftus 1978, p. 41) making comparison difficult. It appears, however, that survivors were more numerous in 1978 and that this will be the stronger of the two year classes.

WHITEFISH AND LAKE HERRING:

Bruce

Median weekly CUE values for larval whitefish and lake herring in the Bruce area are given in Table 6. Whitefish catches were greatest in Pike Bay and lake herring catches were greatest in the Fishing Islands, particularly in Howdenvale Bay.

There were no apparent differences in the hatching times of these species and they were usually taken together in catches. There was evidence of strong covariation in catch size of the two species at individual sites.

Table 6. Median weekly CUE values for lake whitefish and lake herring in the Bruce area, 1978.

	Pike Bay	Stokes Bay	Fishing Islands
WHITEFISH			
April 23-29	26	25	0
April 30-May 6	65	48	121
May 7-13	204	128	97
May 14-20	75	7	26
May 21-27	4	0	0
May 28-June 3	0	0	0
HERRING			
April 23-29	20	6	0
April 30-May 6	41	20	152
May 7-13	9	43	22
May 14-20	0	10	8
May 21-27	0	0	0
May 28-June 3	0	0	0

Herring larvae tended to be several millimetres smaller than the whitefish over the entire sampling period.

Newly hatched larvae could be taken over rock shoal areas close to shore and it is probable that these are spawning sites. Several such sites were located with little effort and numerous others undoubtedly exist throughout the Bruce area that are either too small or too inaccessible to have drawn the attention of commercial fishermen.

The spatial distribution of whitefish and herring larvae appeared to change over the first few weeks of sampling as a result of movement into warmer, more protected areas such as Irish Harbour and inner Pike Bay.

Catch data given in Table 7 suggest that more whitefish hatched in 1978 than in 1977, but fewer appear to have survived. The 1977 catch data are incomplete, but still they show that whitefish larvae were less abundant in that year until June. No whitefish larvae were caught in

Table 7. Median weekly CUE values of whitefish and lake herring in the Fishing Islands, 1976-1978.

	1976	1977	1978
WHITEFISH			
April 23-29	4	1	0
April 30-May 6	-	-	121
May 7-13	24	10	97
May 14-20	-	20	26
May 21-27	0	-	0
May 28-June 3	0	1	0
June 4-10	-	3	-
HERRING			
April 23-29	0	0	0
April 30-May 6	-	-	152
May 7-13	0	3	22
May 14-20	-	12	8
May 21-27	0	-	0
May 28-June 3	0	0	0
June 4 - 10	-	0	-

June of 1978, although some were seen avoiding the net. This suggests that losses to the 1978 year class left it weaker than that of 1977. It may be significant that the apparent decline in larval whitefish and herring abundance in 1978 occurred shortly after yellow perch larvae reached their greatest level of abundance. Interspecific competition for food may have resulted in whitefish mortality or whitefish emigration.

Table 7 indicates that herring larvae were much more abundant in 1978 than in either of the two preceding years. Therefore, the 1978 year class of herring may be relatively strong. This may be an indication of some recovery of herring stocks, which have been greatly depressed since the mid 1950's.

Severn Sound

As in 1977, lake herring and whitefish larvae were incidental in catches at Bergie Point, Port Severn and Beausoleil Island. It is now evident from size at capture that spawning occurs at or near each of these locations and probably at other sites where observations have not yet been made.

OTHER SPECIES

The relative abundance of each taxon identified in catches is given in Tables 8 and 9. Black crappie *(Pomoxis nigromaculatus)*, sunfish *(Lepomis sp.)* and cyprinids comprised a large proportion of the total catch in Severn Sound. The only abundant, non-target species in the Bruce area samples was carp *(Cyprinus carpio)*. These were very numerous in a small number of catches made in Regatta Bay.

Species which had not been previously captured in Severn Sound included troutperch *(Percopsis omiscomaycus)*, longnose gar *(Lepisosteus osseus)*, largemouth bass *(Micropterus salmoides)* and burbot *(Lota lota)*. White bass *(Morone chrysops)*, logperch *(Percina caprodes)* and walleye *(Stizostedion vitreum)* were taken only in small numbers. Several very lightly pigmented larval walleye were collected in Matchedash Bay.

Larval alewife *(Alosa pseudoharengus)*, burbot and deepwater sculpin *(Myoxocephalus quadricornis)* were captured in the Bruce area for the first time. Sunfish, johnny darters *(Etheostoma nigrum)* and gizzard shad *(Dorosoma cepedianum)* were captured only in Pike Bay.

Table 8. Catch per unit effort (CUE) and percent catch composition by species (%) for larval tows from the Bruce area, 1978.

	Stokes Bay		Pike Bay		Red Bay		Howdenvale		Regatta Bay	
	CUE	%	CUE	%	CUE	%	CUE	%	CUE	%
A. pseudoharengus	0.3	0	4.4	0.3	0	0	0	0	0	0
C. commersoni	0.7	0.1	0.2	0	0	0	0.8	0.4	0	0
C. artedii	12.6	1.4	13.4	0.8	24.6	10.4	48.5	24.0	9.3	3.8
C. clupeaformis	34.4	3.7	48.1	3.0	21.2	9.0	46.4	23.0	22.7	9.3
Cyprinidae	0.5	0.1	2.7	0.2	0.5	0.2	1.3	0.6	0	0
C. carpio	0.1	0	0.6	0	0	0	0.8	0.4	205.8	84.0
D. cepedianum	0	0	0.2	0	0	0	0	0	0	0
E. nigrum	0	0	0.4	0	0	0	0	0	0	0
Lepomis spp.	0	0	0.4	0	0	0	0	0	0	0
L. lota	0.1	0	0.2	0	3.6	1.5	0.4	0.2	1.7	0.7
M. dolomieui	0.1	0	0.2	0	0	0	0	0	0	0
M. quadricornis	0.1	0	0.2	0	0	0	0	0	0	0
N. crysoleucas	0	0	0.2	0	0	0	0	0	0	0
O. mordax	2.3	0.2	1.9	0.1	0.9	0.4	2.3	1.1	2.5	1.0
P. flavescens	874.0	94.5	1544.4	95.5	185.6	78.5	101.4	50.2	2.9	1.2
Number of tows	83		54		34		31		21	
Mean C.U.E.	925.2		1617.5		236.4		201.9		2449.9	

Table 9. Catch per unit effort (CUE) and percent catch composition by species (%) for larval tows from Severn Sound, 1978.

	Bergie Point		Matchedash		Tanner Point		Beausoleil		Port Severn		Penetang	
	CUE	%	CUE	%	CUE	%	CUE	%	CUE	%	CUE	%
A. pseudoharengus	9.3	0.2	1.0	0	0.4	0	2.0	0.2	1.8	0.6	2.5	0.9
Catostomidae	0	0	0.5	0	2.5	0	0	0	0.4	0.1	0	0
C. artedii	1.4	0	0	0	0	0	0.3	0	0	0	0	0
C. clupeaformis	1.9	0	0	0	0	0	0.8	0.1	0.8	0.3	0	0
Cyprinidae	627.9	11.4	20.2	0.8	295.6	2.8	74.6	9.2	38.8	3.2	2.1	0.7
C. carpio	0	0	0.7	0	0	0	1.5	0.2	0.2	0.1	3.3	1.2
D. aepedianum	0	0	0	0	0	0	0	0	0	0	0	0
E. nigrum	6.5	0.1	2.0	0.1	60.4	0.6	7.3	0.9	8.8	3.2	0	0
L. sicculus	0	0	0	0	3.2	0	0	0	0	0	0	0
L. osseus	0	0	0	0	0.3	0	0	0	0	0	0	0
Lepomis spp.	23.0	0.4	103.7	4.0	252.3	2.4	82.4	10.2	11.0	4.0	5.1	1.8
L. lota	0.3	0	0	0	0	0	1.3	0.2	0.3	0.1	4.2	1.5
M. dolomieui	0	0	0	0	0	0	0	0	0	0	0	0
M. salmoides	0	0	0	0	0	0	0	0	0.6	0.2	0	0
M. chrysops	0	0	2.0	0.1	0	0	0	0	0	0	0	0
M. quadricornis	0	0	0	0	0	0	0	0	0	0	0	0
N. atherinoides	0	0	0.3	0	0	0	0	0	0	0	0	0
N. cryscleucas	2.8	0.1	4.4	0.2	3.6	0	0	0	0	0	0	0
N. hudsonius	0.2	0	0	0	0.7	0	0	0	0	0	0	0
O. mordax	3.2	0.1	0.3	0	0	0	4.3	0.5	0.6	0.2	0.3	0.1
P. flavescens	4834.2	87.7	960.3	36.7	10,000.8	94.0	624.3	77.1	208.1	75.0	200.9	71.4
P. caprodes	0	0	3.4	0.2	0	0	0.8	0.1	0.2	0.1	0.3	0.1
Percidae	0.5	0	0	0	0.7	0	0	0	0	0	0	0
P. omiscomaycus	0	0	0	0	0	0	0.4	0	0	0	0	0
P. nigromaculatus	3.2	0.1	1516.6	58.0	13.1	0.1	9.6	1.2	5.6	2.0	62.5	22.5
S. vitreum	0	0	0.7	0	0	0	0	0	0.2	0.1	0	0
Number of tows	37		29		26		28		36		32	
Mean C.U.E.	5514.4		2616.1		10,633.6		809.5		277.4		281.1	

DISCUSSION

PROGRAM STATUS:

The year 1978 was the first in which a predetermined sampling schedule was successfully maintained. It is our view that the monitoring is effective and that the sampling design is now sufficiently well-developed to meet the main program objective of providing good annual indices of abundance for the species to be monitored.

In keeping with the situation presented by Lake Huron, the sampling design is far more extensive than those employed in small lake studies (Faber 1976, Forney 1976, Noble 1968). It presents no major operational difficulties and can be implemented in its present form on a routine basis.

INDICES OF ABUNDANCE

Area-wide indices of abundance are necessary for between-area comparisons. Such indices should attach equal importance to all sites within a sampling area if systematic variation

is known to occur. This can be done by expressing individual index values as proportions of some baseline datum, such as an average index value obtained from several years of sampling at a site, and then using the arithmetic mean of these proportions as an area-wide index. This approach involves the assumption that systematic between-site differences in productivity remain constant in the short term (the inevitability of long-term, episodic changes must be accepted).

The time series of catch data collected in this program is not yet sufficient for the standardization of index values. The interim approach to calculating area-wide indices of yellow perch abundance involves adding successive median weekly catches of recruits and survivors. The medians are calculated using all individual catch data from within the area. The median is considered to be a more conservative statistic than either the arithmetic or geometric mean.

The most useful indices for long-term comparison are judged to be the r, s and total catch values calculated for each site. Because values of r and s are obtained from cumulative catch data, complete maintenance of the sampling schedule is essential.

MORTALITY

The change in abundance (Δa) of yellow perch larvae between the recruits and survivors stages can be expressed in terms of the equation:

$$\Delta a = \frac{(s - r)}{r} * 100$$

The value of Δa for a particular site is a function of mortality (m), which is always negative in value, and the migration rate (k) which may be either positive or negative, that is

$$\Delta a = m + k$$

If immigration occurs k has a positive value and if the immigration rate exceeds the mortality rate the value of Δa will also be positive. This appears to offer an explanation for the positive values of Δa in Table 10. Fishing mortality due to sampling is assumed to be inconsequential.

Immigration, like emigration, may be voluntary if the larvae actively move into favourable areas, and involuntary if they are transported from one area to another by lake currents. The highest values of Δa occurred at Red Bay and Howdenvale Bay where recruitment was very low. In Regatta Bay, where there was no observed recruitment, the value of Δa was equal to infinity. High negative values, such as those observed at Tanner Point and Port Severn, may have resulted from high mortality rates, emigration, or both.

Table 10. Relative changes in abundance (Δa) of perch larvae between recruit and survivor stages in Severn Sound and the Bruce area, 1978.

Site	Δa
Tanner Point	-0.95
Port Severn	-0.90
Penetang Harbour	-0.65
Matchedash Bay	-0.41
Bergie Point	-0.29
Beausoleil Island	-0.24
Stokes Bay	-0.17
Pike Bay	+2.15
Howdenvale Bay	+7.20
Red Bay	+9.92

The value of Δa may remain relatively constant from year to year at a given site if such parameters as recruitment and the passive and active transport of larvae also remain constant. This remains true to the extent that these parameters are influenced by the physical nature of each site. If this influence is strong, as it appears to be, it may be more useful to assess mortality by examining relative year-to-year changes in the value of Δa at a given site rather than the value of Δa itself.

CONCLUSIONS AND RECOMMENDATION

A reasonably satisfactory sampling design has now been established and the program can be implemented on a routine basis.

Lake herring larvae were more abundant in 1978 in the Fishing Islands than in previous years and this indicates that the 1978 year class will be relatively strong. This bodes well for the return of the lake herring to its former status in the fish community.

The 1978 year class of whitefish is expected to be stronger than that of 1976 but weaker than that of 1977. This expectation is based on the smaller number of larvae present in late May and early June of 1978 in comparison with 1977.

Yellow perch hatched later in 1978 than in 1977 and the hatch was larger and more compressed. The number of larvae that reached the survivor stage was relatively high and on that basis a relatively strong 1978 year class of yellow perch is forecast.

The catch data suggested that the majority of whitefish, herring and yellow perch captured at various sites were of local origin and that even the larger specimens had not travelled more than one or two kilometers. This appears to be true for other species as well, including deepwater sculpin. Walleye larvae are exceptional because they may be transported for several kilometers from their hatching sites by river currents.

It is recommended that District Offices consider the feasibility of implementing spatial surveys of larval fish abundance in the Lake Huron waters within their respective jurisdictions. Relatively inexpensive surveys could be conducted that would yield more definitive information on the distributions of spawning and nursery areas of various fish species.

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